SCORPION DISTRIBUTION IN A DUNE AND SWALE MALLEE ENVIRONMENT

N.A. LOCKET

Locket, N.A. 1993 11 11: Scorpion distribution in a dune and swale mallee environment. *Memoirs of the Queensland Museum* **33**(2): 593-598, Brisbane. ISSN 0079-8835.

A system of stable and vegetated dunes, separated by occasionally flooded swales, contains populations of six scorpion taxa. *Urodacus yaschenkoi* (Birula) digs deep burrows in the soft soil of the dunes, but the shallower burrows of *U. armatus* Pocock are concentrated at their base, extending onto the swale for ca. 50m. *Lychas jonesae* Glauert, *L. variatus* (Thorell) and *Isometroides angusticaudis* Keyserling occur on the swale but not the dunes. *Cercophonius kershawi* Glauert has occasionally been found in litter beneath mallee trees on the dunes. Soil hardness may account for *U. yaschenkoi* occurring only on the dunes. *Isometroides*, a spider predator, occurs where spider burrows are found. Predation by the larger *Urodacus* may account for the buthids not extending onto the dunes.□ *Scorpions, Australia, ecology, habitat.*

N.A. Locket, Department of Anatomy and Histology, University of Adelaide, Box 498, GPO, Adelaide, South Australia 5001, Australia; 3 November, 1992.

An area of scrub near Berri in the South Australian Riverland consists of a series of stable dunes bearing mallee trees and shrubs interspersed with flat grassy swales, which show signs of occasional flooding. This locality contains a population of *Urodacus yaschenkoi*. Blacklighting on and between the dunes showed that five other scorpion taxa are present in the area but not uniformly distributed. Observations are now presented on these populations and their distribution across the dune- swale system.

Two of the taxa found do not accord with the descriptions given by Koch (1977). One, a *Lychas*, corresponds to Glauert's (1925) unillustrated description of *L. jonesae*, apparently from a single specimen collected near Kalgoorlie, Western Australia. Koch (1977), who examined the holotype, included *L. jonesae* in *L. marmoreus* but did not give reasons for doing so. The present specimens resemble *L. alexandrinus*, widely distributed in arid Australia (Koch, 1977, map 4), but differ significantly from it and from *L. marmoreus*. They agree closely, except in colouration, with the (markedly faded) type of *L. jonesae*. An illustrated redescription of *L. jonesae* is in preparation, and the present specimens referred to that species meanwhile.

The other belongs to the genus *Isometroides*, which Main (1956) suggested was monospecific, all specimens being referable to *I. vescus*, a view supported by Koch (1977). The Berri specimens agree better with the descriptions of Keyserling (1885), Kraepelin (1916) and Glauert (1925, 1963) of *I. angusticaudis*, and are certainly not typical of *I. vescus*. An account of the genus *Isometroides* is in preparation, and the present specimens referred to *I. angusticaudis* in anticipation of that work.

Many factors influence the distribution of scorpions, including latitude and climate, type of terrain and soil hardness. Biotic factors such as intra-guild competition and predation are also important (Polis, 1990). The latitude of the study site, ca 34°, is within the range of maximum scorpion diversity, given by Polis (1990) as 23-38°. Within this belt up to ca 10 species may occur sympatrically in the northern hemisphere, though most locales have only 3-7. Diversity is greatest in desert regions, with 24 of the 28 communities of six or more being in subtropical deserts, where terrain may range from loose sand to hard packed stony ground. Soil hardness was closely related to species distribution in *Opisthophthalmus* by Lamoral (1978). Bradley (1986) showed that populations of the burrowing *Paruroctonus utahensis* were denser on soft soils than hard, and that its burrowing was impaired by the hardening of the soil due to rain. Vegetation patterns correlated both with soil type and scorpion population, but areas with different scorpion densities contained similar biomass of potential prey. Bradley also demonstrated the destruction caused by flooding to a population of *P. utahensis*.

Polis (1990) shows that biotic factors may well affect the composition and balance of a population. He gives strong evidence on the important influence of scorpions on the community in which they live, by competition through predation on other invertebrates or cannibalism of smaller scorpion species, and of smaller conspecific instars. Individual scorpions of different species but similar size may well compete direct-

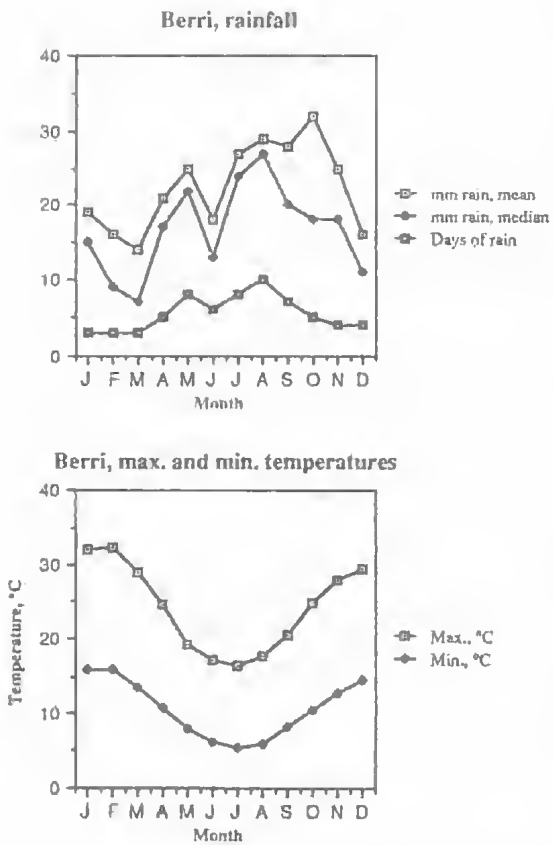

FIG. 1. Temperature and rainfall, Berri (nine year average).

ly for food, since most are generalist predators, perhaps leading to one species becoming dominant. Different sized scorpions may take different groups of prey, based on size, though the young of a large species may compete directly with adults of a smaller when the individuals are of comparable size.

METHODS

The site is about 8 km NNE. of Berri, 140°38'E, 34°13'S, in the South Australian Riverland. The climate at Berri is warm and dry (Fig. 1). A transect 10m wide was laid out from dune to dune across a swale, some 300m. The nature of the soil was noted, and trees and shrubs more than a few cm high plotted to the nearest 1m.

Single-, or on one occasion two-day, visits were made to the study site on fourteen occasions, on moonless nights when possible, between March 1989 and May 1992. On each visit the

Date	*U.yasch.*	*U.armat.*	*L.angust.*	L.variatus	*L.jonesae*
16 Sep 89	0	0	4	0	0
24 Mar 90	4	3	4	0	1
15 Sep 90	0	1	2	0	3
20 Oct 90	0	0	10	0	7
10 Nov 90	0	0	6	0	27
15 Dec 90	0	0	11	2	21
15 Jan 91	0	0	11	0	16
16 Mar 91	0	11	0	0	18
5 Oct 91	14	14	2	2	1
2 Nov 91	0	0	5	0	1
7-8 Dec 91	9	6	5	1	70
2 Feb 92	1	1	1	0	41
29 Feb 92	6	11	11	1	59
2 May 92	0	2	6	1	
TOTAL	34	52	78	6	265

TABLE 1. Catches of scorpions, blacklighting only.

parts of the transect containing the characteristic burrows of *Urodacus yaschenkoi* were noted. On one occasion in summer all the burrows within the transect were marked with numbered tags. Burrow identification was confirmed and specimens obtained by trapping burrows away from the transect. The traps were plastic vending machine cups, ca 200cc capacity, dug into place at the burrow mouth, the burrow opening directly at the lip of the cup. The traps were visited at least 1h after sunset, when scorpions had emerged from the burrows and fallen into the cup.

Smaller burrows, without the curved entrance of *U. yaschenkoi*, were identified as those of *U. armatus* by digging out the scorpion. On three occasions *U. armatus* was identified by blacklight at a burrow mouth which was then marked and examined next day.

Blacklighting was carried out, away from the transect but within the dune-swale system, on each visit by two persons, working parallel to each other and approximately 100m apart. Blacklighting, commencing at various times after sunset, on some occasions as soon as it became dark enough and on others up to 1.5h after sunset, was continued for ca 2h.

Urodacus yaschenkoi and *U. armatus* could be distinguished in the field by blacklight. *Isometroides*, except very small individuals, was distinguishable from the *Lychas* species, but the two *Lychas* could not be told apart until the catch was examined indoors. This took place on return from the field, when notes on weather, capture sites and behaviour were written. Detailed plots of specimen location were not made, but it was possible to assign the taxa to dune, dune base or

FIG. 2. View of transect across swale, looking north from southern dune. 1, sandy soil at base of dune. 2, low bank beside old track. 3, track. 4, swale. 5, far dune. See also Figs 3 and 4.

swale. Identifications were confirmed on return to the laboratory.

RESULTS

The transect, running N-S, extends 300m from the top of one dune, ca 6m high, across the flat swale, to the top of the next dune (Fig. 2). The dunes bear scattered mallee trees, *Eucalyptus oleosa* and *E. brachycalyx*, numerous bushes of native hop, *Dodonaea* sp., and clumps of *Spinifex*. The swales are lightly covered with grass and other low plants, with sparse bushes of native hop and of *Cassia nemophila* var. *platypoda* (Fig. 3).

Catch data are summarised in Table 1 and distributions in Fig. 4. *Urodacus yaschenkoi* burrows occur on the dunes, mainly in the open but a few under light cover. In January 1991, 80 burrows were located and marked within the transect, but by October, 56 tags either were not related to a visible burrow or had been disturbed by animals. Of the three *U. armatus* burrows marked while blacklighting, two had been closed by next day, and would have been missed apart from the marker. No further attempts were made to trace the fate of individual burrows. Individual *U. yaschenkoi*, usually adult males, were found by blacklighting in December-February, mainly on the dunes but including one ca. 50m onto the swale. *U. yaschenkoi* were also observed at their burrow mouths by blacklight in summer.

Urodacus armatus burrows were occasionally found on the dunes, but most were at the dune base and for up to 50m onto the swale. *U. armatus*, mostly immature, found by blacklight had a similar distribution , with occasional examples up to ca 100m onto the swale. Immature individuals have sometimes been found clinging to low vegetation within a few cm of the ground. *U. armatus*, recognisable by blacklight from *U. yaschenkoi* by their squat pedipalps, have been seen at the burrow mouth between October and February.

Three species of buthid, *Lychas jonesae*, *L. variatus* and *Isometroides angusticaudis* have been found, only on the swale, by blacklighting. *L. jonesae*, commonest overall, though on occasions outnumbered by *I. angusticaudis*, occurs all across the swale, but often near low vegetation near the dune base. Some have been found clinging to stems within a few cm of the ground.

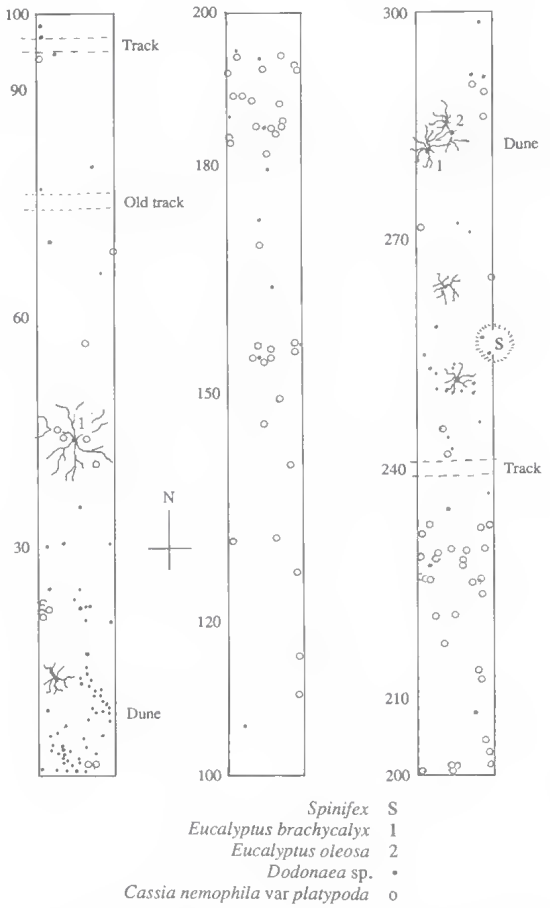

FIG. 3. Plot, to scale, of distribution of major plants across transect. Distances in metres.

mostly head down, but none have been found high in bushes.

Lychas variatus has been taken occasionally, never more than two and frequently none, in an evening. Insufficient have been found to comment on their distribution on the swale.

Isometroides angusticaudis has mostly been found on the surface by blacklight, among low grass rather than taller vegetation and extending up to but not above the dune base. A few have been dug by day from the burrows of lycosid spiders, abundant on the swale but not the dunes.

One *Cercophonius kershawi* (identified from Acosta (1990)) was found in May 1992 by kicking over leaf litter beneath mallee trees while blacklighting. (Two juvenile *Lychas variatus* were caught in the same way on dunes within 1 km of the transect in June 1987).

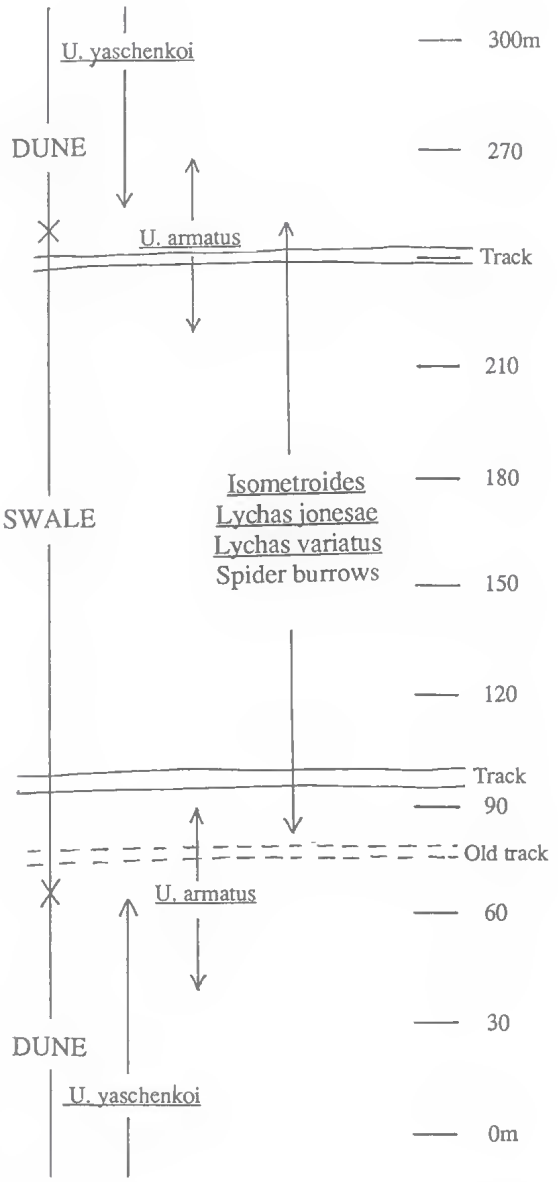

FIG. 4. Distribution of scorpions across dune and swale system. *Urodacus yaschenkoi* occurs on the dunes, *U. armatus* at their bases and the three buthids on the swale.

DISCUSSION

Many labels in collections state a locality, without details of microhabitat. The population disparity now described from localities a few meters apart suggests that it may be helpful to define localities more precisely.

Lamoral (1978), studying two burrowing

species of *Opisthophthalmus*, found clear separation of two otherwise sympatric species, strongly correlated with soil hardness, a factor probably also important in *Urodacus*. Koch (1978) found the depth and tortuosity of *Urodacus* burrows within a species greater with aridity. There is also a species difference: *U. yaschenkoi* and *U. hoplurus* dig deeper and more spiral burrows than *U. armatus*. Koch (1981) noted that *Urodacus* scorpions show little correlation with soil type, but more with softness and the chance of reaching water by burrowing. Shorthouse (1971), Shorthouse and Marples (1980) and Koch (1978) have described the spiral burrows up to 1m deep of *U. yaschenkoi* in loose sandy soil. The dune soil at Berri is of this type. Most burrows of *U. armatus*, seldom more than 30cm deep, are in the firmer soil at the dune base and swale, though some occur up the dunes, in what appears otherwise to be *U. yaschenkoi* territory.

Koch (1981) considered three Australian zones, a moist temperate southern, semi-arid to desert central and humid tropical northern, associating various scorpions with these zones: *Urodacus yaschenkoi* and *U. armatus* he regarded as mainly central forms. He found scorpion distribution not correlated with vegetation type, single species occurring in a wide range of habitats. He suggested that range-determining factors include temperature, precipitation and biotic factors, e.g. competitive exclusion. He also examined morphological characters, suggesting that large size, longer metasomal segments and spines, more granulation, and higher pectine tooth counts are aridity-linked in *Urodacus*, while large size, light colouration, more granulation, higher pectine tooth counts and a less prominent subaculear tooth are aridity- linked traits associated in *Lychas*. He regarded *Isometroides* as showing the culmination of these buthid traits. Of the sympatric species at Berri, both *Urodacus* are pale and smooth, their pectine counts largely overlap, but *U. yaschenkoi* is large and *U. armatus* small. *L. variatus* and *I. angusticaudis* are both pale but mottled though *L. jonesae* is small and dark, with subaculear tooth intermediate between the other two buthids.

The swale, where *Isometroides* has been collected by blacklight, contains numerous lycosid spider burrows, up to 30cm deep in hard soil. *Isometroides* was recognised by Main (1956) as a spider predator and collected by her from their burrows. Four have been so collected in the present study, but no concerted digging has been done.

The habit of clinging to vegetation close to the ground, also observed in immature *U. armatus* by G.T. Smith (personal communication), may enable scorpions to avoid wandering predators. Some scorpions, e.g. *Centruroides exilicauda* in America, are frequently found in bushes well off the ground, but such climbing has not been seen in the present case.

The total catches of buthids suggest that *Lychas jonesae* is dominant on the swale, though on occasions more *Isometroides* have been caught. *L. variatus* is much less common than either. *Isometroides* is known to be a specialist burrowing spider predator. Probably the *Lychas* species are less specialised, though little is known of their diet; one instance of *L. jonesae* eating an immature *U. armatus* was the only act of predation observed. Insufficient is known of the habits of the two *Lychas* to indicate why the smaller should be commoner.

ACKNOWLEDGEMENTS

I thank Deirdre Locket and G.R. Johnston for assistance in the field and with plant identification and Rae Sexton for assistance with plant identification; Dr D.C. Lee (South Australian Museum), Dr A. Yen (Museum of Victoria) and Dr M.S. Harvey (Western Australian Museum) for access to specimens in their care; and the Bureau of Meteorology for climatic data.

LITERATURE CITED

ACOSTA, L.E. 1990. El genero *Cercophonius* Peters, 1861 (Scorpiones, Bothriuridae). Boletin de la Sociedad de Biología de Concepción (Chile) 61: 7-27.

BRADLEY, R.A. 1986. The relationship between population density of *Paruroctonus utahensis* (Scorpionida: Vaejovidae) and characteristics of its habitat. Journal of Arid Environments 11: 165-172

GLAUERT, L. 1925. Australian Scorpionidea. Part 1. Proceedings of the Royal Society of Western Australia 11: 89-118.

1963. Check list of Western Australian scorpions. Western Australian Naturalist 8: 181-185.

KEYSERLING, E. 1885. Part 32. Pp. 1-48. In Koch, L. and Keyserling, E. 'Die Arachniden Australiens nach der Natur beschrieben and abgebildet'. (Bauer & Raspe: Nürnberg).

KOCH, L.E. 1977. The taxonomy, geographical distribution and evolutionary radiation of Australo-Papuan scorpions. Records of the Western Australian Museum 5: 81-367.

1978. A comparative study of the structure, function and adaptation to different habitats of burrows in

the scorpion genus *Urodacus* (Scorpionida, Scorpionidae). Records of the Western Australian Museum 6: 119-146.

1981. The scorpions of Australia: aspects of their ecology and zoogeography. Pp. 875-884. In Keast, A. (ed.), 'Ecological biogeography of Australia'. (Junk: The Hague).

KRAEPELIN, K. 1916. Results of Dr E. Mjöberg's Swedish scientific expeditions to Australia 1910-1913. 4. Scolopendriden und Skorpione. Arkiv für Zoologi 10: 1-43.

LAMORAL, B.H. 1978. Soil hardness, an important and limiting factor in burrowing scorpions of the genus *Opisthophthalmus* C.L. Koch 1837 (Scorpionidae, Scorpionida). Symposia of the Zoological Society of London 42: 171-181.

MAIN, B.Y. 1956. Taxonomy and biology of the genus *Isometroides* Keyserling (Scorpionida). Australian Journal of Zoology 4: 158-164.

POLIS, G.A. 1990. Ecology. Pp. 247-293. In Polis, G.A. (ed.), 'The biology of scorpions.' (Stanford University Press: Stanford).

SHORTHOUSE, D.J. 1971. 'Studies on the biology and energetics of the scorpion *Urodacus yaschenkoi*.' (Unpublished Ph.D. Thesis, Australian National University: Canberra).

SHORTHOUSE, D.J. & MARPLES, T.G. 1980. Observations on the burrow and associated behaviour of the arid zone scorpion *Urodacus yaschenkoi* Birula. Australian Journal of Zoology 28: 581-590.